Global Precipitation Measurement

System Definition Review Mission Overview



December 6 - 8, 2005

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- EOS-9 Endorsed at EOS Planning Workshop, 1998
- Design Center Studies, 1999-2001
 - 2 IMDC Sessions, 2 ISAL runs, 1 Team X study, 4 RSDO studies, and 1 in-house feasibility study
- FY02 Begin Formulation assume in-house
 - Initiate Partnership discussions
 - Develop Programmatics and Management Planning
 - Complete System Requirements Definition
- Held successful SRR June 2002
- Held successful Spacecraft Concept Review December 2002 based on in-house
- Held majority of subsystem Peer Reviews by June 2004 based on in-house
 - Project activities were within 6 months of spacecraft PDR
- FY04 redirected to investigate out-of-house
 - Conducted 100 day RSDO vendor study fall 2004
- FY05 redirected to Hybrid approach
 - Two phased approach
 - Multi-vendor 4 month study to finalize avionics requirements
 - Award an implementation contract with one RSDO vendor



- Previous in-house activity demonstrated requirements traceability and design feasibility via subsystem peer review process
- 100 day RSDO Study demonstrated performance requirements are achievable
 - 3 vendors with commercial avionics products can meet the driving requirements
- All mission architecture work still applicable to Hybrid development
 - System trades: S/A sizing, battery chemistry and sizing, TDRSS MA vs. GN. etc.
- Mission level requirements documentation still applicable:
 - MAR, Level 1, 2 & performance specifications
 - Mission Operations Concept documentation
- Many subsystem level requirements development still applicable
 - H-2A coupled loads analysis
 - Rigid & flexible body control analysis
 - Reaction Wheel sizing analysis
 - Delta-V and prop sizing analysis
 - Solar Array slip ring size analysis
 - Grounding scheme



GPM's mission:

- Take TRMM measurements global and improve temporal sampling and microphysics understanding
 - Since a single spacecraft can't be all places at all times it requires a constellation of satellites
 - The number of satellites required (5 to 8) is cost prohibitive for any single funding agency

So,

 The GPM mission is an inter-agency and international partnership mission



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GPM Reference Concept

OBJECTIVES

 Understand horizontal & vertical structure of rainfall, its macro- & micro-physical nature, & its associated latent heating

• Train & calibrate retrieval algorithms for constellation radiometers

OBJECTIVES Constellation

- Provide sufficient global sampling to significantly reduce uncertainties in shortterm rainfall accumulations
- Extend scientific and societal applications

Core Satellite

- TRMM-like spacecraft (NASA)
- H2-A rocket launch (TBC, JAXA)
- Non-sun-synchronous orbit
 - ~ 65° inclination
 - ~407 km altitude (circular)
- Dual frequency radar (JAXA) Ku-Ka Bands (13.6-35.5 GHz)
 - ~ 4 km horizontal resolution
 - ~250 m vertical resolution
- Multifrequency radiometer (NASA) 10.65, 18.7, 23.8, 36.5, 89.0, 166, 183.3 GHz

Constellation Satellites

- Pre-existing operationalexperimental & dedicated satellites with Passive Microwave radiometers
- Average revisit time 3-hour over >80% of globe
- Sun-synch & non-sun-synch orbits 600-900 km altitudes

Ground Validation Sites

- Ground measurement & calibration
- Cooperative international partners

Precipitation Processing System

Core

• Global precipitation products from input data provided by a consortium of international partners



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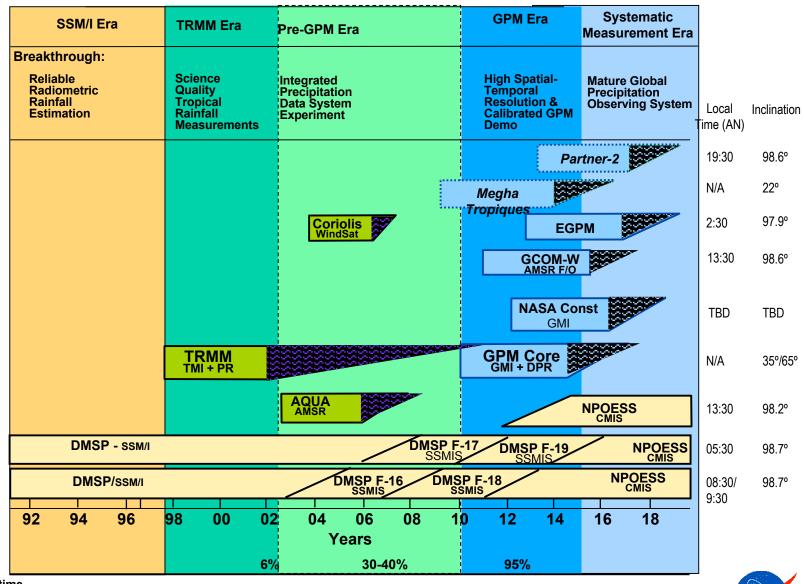
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Constellation Build-Up

GODDARD SPACE FLIGHT CENTER



average revisit time

SDR December 6-8, 2005 - Mission Overview

Coverage of 3h

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"Rolling Wave" Build-Up of GPM Constellation

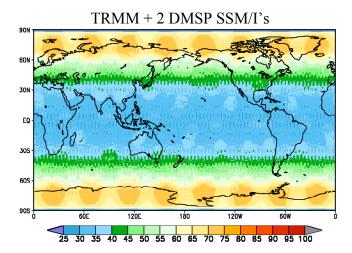


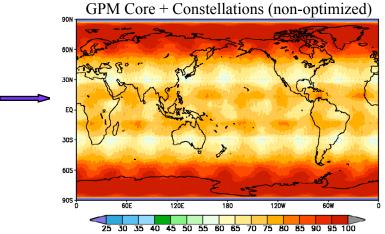






Percent of time with 8 times daily sampling





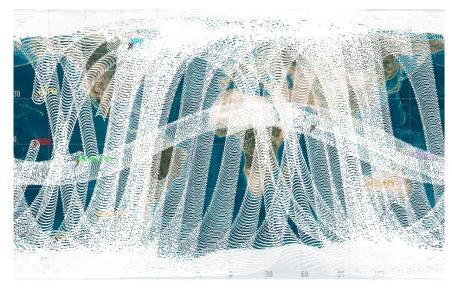


Typical 3-Hour Coverage

· GPM Core

50 120 90 60 30 D 30 BD 90 120 150

• Core, DMSP-F18, DMSP-F19, GCOM-W, NASA-Constellation, EGPM, Megha-Tropiques, NPOESS







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Constellation Optimization Analysis

Notional 6 satellite constellation 3 hour global coverage:





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- Many constellation architecture trades have been done in close coordination with the science community to maximize science return and mission probability of success
 - Minimize dependencies on elements NASA has no control over
 - Maximize utilization of existing US assets
- The project has developed a two-tier Level 1 Science Requirement set:
 - Full Mission Requirements
 - Includes all available assets both foreign and domestic
 - Base Mission Requirements
 - Includes US only assets

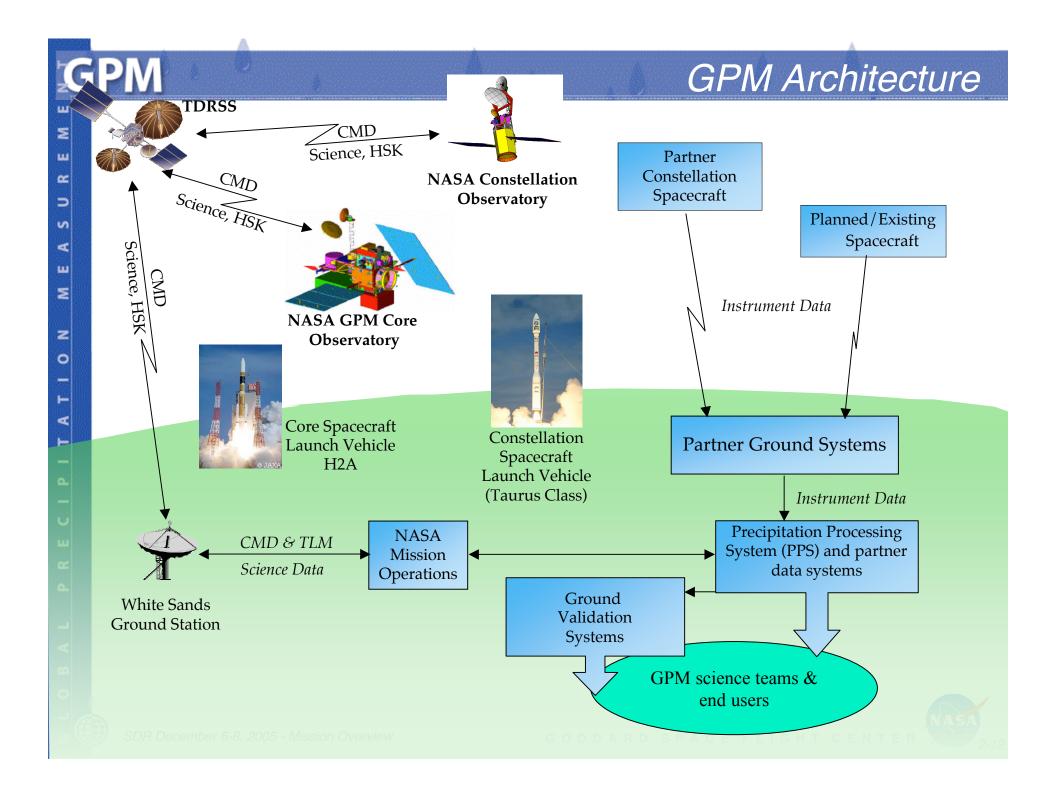


JAXA/NASA partnership on Core spacecraft development

- NASA providing overall project management/system engineering
- NASA providing GMI
- NASA providing the spacecraft
- NASA providing mission operations
- JAXA providing DPR
- JAXA providing H-IIa L/V (TBC)*
- NASA/Radiometer data stream providers, e.g. NOAA, USAF, CNES/ISRO, JAXA, NSPO, ESA, AEB
 - Full mission Level 1 requirements require international contributions
 - Base Level 1 requirements require US-only contributions

* JAXA has still to commit to providing the L/V and US has yet to approve utilizing the H-IIa – NASA budget assumes they will but the core development design will be compatible with both H-IIa & FELV





Implementation Approach

- Core Spacecraft: Hybrid approach
 - Combination in-house/RSDO development
 - GSFC maintains overall system engineering responsibility
 - Isolates fixed price environment from programmatic uncertainties
 - JAXA providing L/V
 - International contribution of critical components schedule risk
 - Launch site operations foreign vs. domestic
 - Maintains core engineering competencies at GSFC
 - Utilizes flight proven commercial off-the-shelf avionics
- GMI Instrument: Industry competitive development
 - Ball selected March 2005
 - One instrument with option for 2nd instrument
- DPR Instrument: JAXA/Japanese industry development
 - JAXA (including NICT) working on DPR since late 2001
 - Industry partner (NTSpace) in place since late 2004
- Constellation spacecraft: Competitive RSDO development
- Science Date Processing system: In-house development
 - PPS leverages off of TRMM processing system (TDIS)
- Ground System: In-house development
- Ground Validation System: Industry/University development







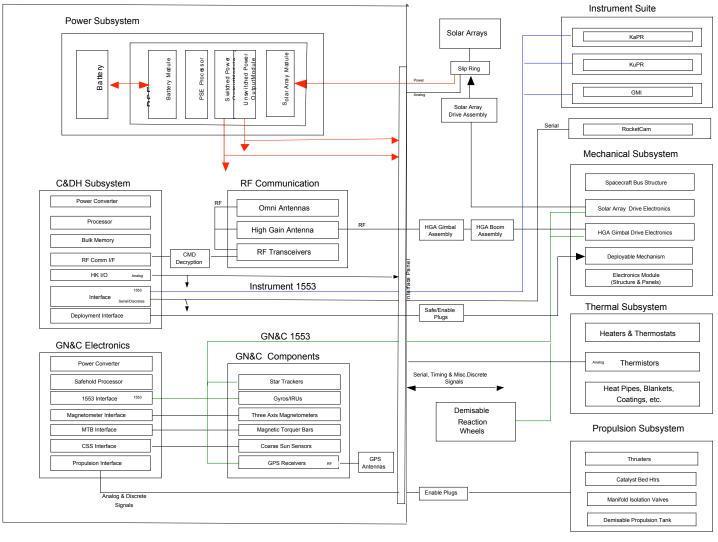
Hybrid Approach

Notional GPM Hybrid System Block Diagram

Revision 1.8.2

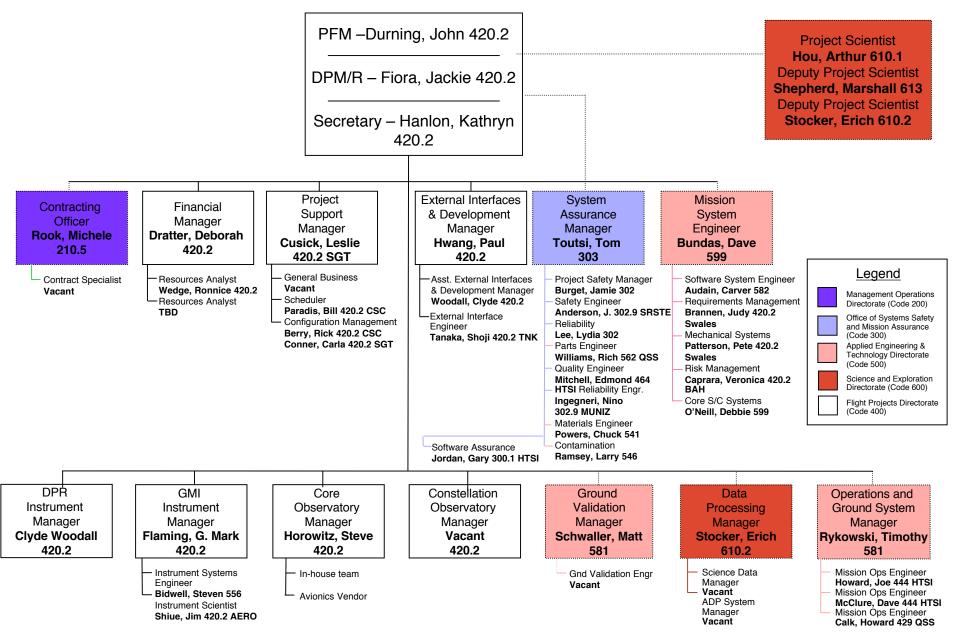
October 28, 2005 RSDO Supplied Avionics Package

Non-RSDO Supplied Bus Components





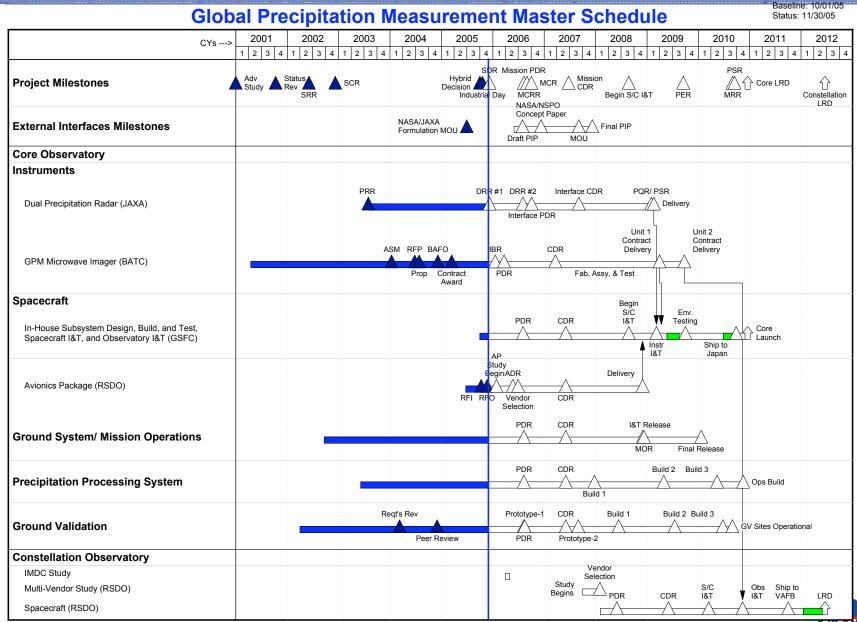
GPM Project Organization



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- Project team in place
- Engineering team in place
 - Many of the old in-house team has returned as appropriate
 - Most co-located with project on same floor or adjacent building
- Design activity picking up where it left off in 2004 ~6 months short of PDR
- Partnership discussions held with NSPO (Taiwan) and AEB (Brazil) regarding possible constellation contributions and GV participation









Hybrid development approach

- New approach for GSFC
 - Performance requirements are within commercial products performance capabilities
 - Build off TRMM development experience
 - Two phased procurement selection in late FY06

International Partnerships

- Japan critical to mission success
 - Follows same model as TRMM
- JAXA providing the Core launch services
 - HQ driving for JAXA commitment by end of the year
 - Project drafted contingency plans if NASA has to provide L/V
- Data streams
 - No hardware exchange planned
 - Base mission requires only NASA and IPO/DMSP data streams



Challenges (continued)

- Science Data Processing Multiple Asynchronous Data Streams from Diverse Sensors
 - Evolve from TSDIS design
 - SEEDS/IPDS/PPS accelerated implementation retires GPM risk early
 - Trial runs in FY06 & 07 with
 - AMSR
 - Megha-Tropiques
 - Coriolis (possible)
- Ground Validation new part of project development activities
 - Evolve from TRMM GV experience
 - Begin architecture studies very early in mission development
 - Commence field operations ahead of Core LRD
 - Usually heavily science research based
 - Clearly identify and isolate research based from operational based requirements
 - Project responsible for operation based and science team responsible for research based activities



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Mission Level Risk Summary

Risk Title

H-1 International Partners
Commitment

H-2 JAXA Proposed Data Policy

H-3 Uncertain Launch Date

H-4 JAXA Provided Launch Services

H-5 AP Vendor Down Select/PDR Schedule

		Impact					
		1	2	3	4	5	
Probability	5					H-4	
	4				H-3		
	3		H-1	H-5			
	2			H-2			
	1						

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Day 1 - December 6, 2005 Location: NASA GSFC B16W-N76/80

Time	Section	Event	Presenter
8:30 AM		Logistics & Announcements	Durning
8:35 AM	1	Introduction	Durning/Ho
8:45 AM		Charge to Review Team/RIDs: Purpose & Review Criteria	Но
8:55 AM		HQ Overview	Neeck
9:10 AM	2	GPM Mission Overview	Durning
9:55 AM	3	Science Requirements	Hou
10:25 AM		Break	
10:40 AM	4	Mission Requirements	Bundas
11:10 AM	5	Mission Architecture	Bundas
11:55 AM		Lunch	
12:55 PM	6	Systems Engineering Processes	Bundas
1:40 PM	7	System Safety and Mission Assurance	Toutsi
1:55 PM	8	External Interfaces	Hwang
2:10 PM	9	Dual Precipitation Radar (DPR) Overview/Requirements	Woodall
2:55 PM		Break	
3:10 PM	10	GPM Microwave Imager (GMI) Overview/Requirements	Flaming/Bidwell
4:10 PM	11	H-IIA Launch Vehicle	Woodall
4:30 PM		Review Team Caucus	
4:40 PM		End of Day 1	

